U.S. Department of Transportation
Federal Aviation Administration

Advisory Circular

Subject: INITIAL MAINTENANCE INSPECTION (IMI) TEST FOR TURBINE ENGINES	**Date:** xx/xx/xx **Initiated By:** ANE-110	**AC No:** 33.90-1[DRAFT] **Change:**

1. PURPOSE. This advisory circular (AC) provides guidance and acceptable methods, but not the only methods, for demonstrating compliance with the test requirements of §33.90 of Title 14 of the Code of Federal Regulations (14 CFR §33.90), Initial maintenance inspection. The information provided in this AC replaces the guidance in paragraph 61, Section 33.90 IMI, of AC 33-2B.

2. APPLICABILITY.

a. The guidance provided in this document is directed to engine manufacturers, modifiers, foreign regulatory authorities, and FAA engine type certification engineers and their designees.

b. This material is neither mandatory nor regulatory in nature and does not constitute a regulation. It describes acceptable means, but not the only means, for demonstrating compliance with the applicable regulations. The FAA will consider other methods of demonstrating compliance that an applicant may elect to present. Terms such as "should," "shall," "may," and "must" are used only in the sense of ensuring applicability of this particular method of compliance when the acceptable method of compliance in this document is used. While these guidelines are not mandatory, they are derived from extensive FAA and industry experience in determining compliance with the relevant regulations. On the other hand, if the FAA becomes aware of circumstances that convince us that following this AC would not result in compliance with the applicable regulations, we will not be bound by the terms of this AC, and we may require additional substantiation as the basis for finding compliance.

c. This material does not change, create any additional, authorize changes in, or permit deviations from existing regulatory requirements.

3. RELATED REGULATION. 14 CFR §33.90.

4. DEFINITIONS. For the purposes of this AC, the following definitions apply:

a. Initial Maintenance Inspection (IMI). IMIs are those inspections specified in the instructions for continued airworthiness (ICA) submitted under §33.4 that are considered necessary to determine the serviceability of the engine, and that the type certificate (TC) holder requires or recommends at certain intervals.

b. IMI Intervals. IMI intervals are the maximum hours or cycles that an engine should be operated in service before a general hardware serviceability IMI is conducted on engine static and rotating assemblies, systems, and controls. Note that the results of this test run should support the specified general engine IMI interval or module/system-level IMI intervals, as required or recommended for the type design. The results of the §33.90 testing should also support the IMI methods and serviceability limits specified in the ICA.

c. Mission Flight Cycle. A mission flight cycle is the predicted average flight profile, comprised of corresponding engine parameters and effects representative of all identified or intended aircraft applications.

d. Overhaul. Overhaul refers to the process of disassembly, cleaning, inspection, repair as necessary, and reassembly for the purpose of return-to-service, generally recommended to occur at a fixed interval.

e. Serviceable. An engine part, component, or assembly is serviceable if it is in a physical condition acceptable for continued service operation in accordance with the ICA submitted under §33.4.

5. BACKGROUND. Section 33.90 requires each engine model for which a new TC is required to perform a test run that simulates the conditions under which the engine is expected to operate in service, including start-stop cycles that are typical of expected service use. The purpose of this test requirement is to help establish the entry-into-service (EIS) IMI for the type design, and to show that a type design engine remains in a serviceable condition between required or recommended maintenance inspections or fixed overhaul periods, as applicable. Therefore, this AC provides guidance on test methods and procedures, test pass/fail criteria, and EIS IMI or overhaul requirements or recommendations established for the type design. The applicant should also consider the suitability of manual serviceability limits as part of this overall evaluation.

6. CONDUCT of IMI TESTS.

a. IMI Test Cycle Assessment. The applicant should provide an assessment of expected service operating conditions as part of the overall test plan. In the assessment, the applicant should show that the proposed test cycle represents the mission flight cycle regarding established power/thrust ratings, reverse thrust usage, component stress and temperature, exhaust gas temperature (EGT), vibration, and cycle/operating time cumulative damage. For multiple aircraft applications, the applicant should show that the test cycle adequately represents all identified or intended installations. Two types of test cycles have been found to be acceptable for demonstrating the IMI interval(s):

(1) Full Mission Cycle. This method requires the engine to be run through the exact sequences of thrust or power settings for the period of time identified in the mission flight cycle. One complete cycle of a full mission cycle test would involve the exact number of operating hours as a typical flight cycle and includes engine start and shutdown.

(2) Accelerated Mission Cycle. This method is structured to provide a rigorous test of engines (or engine parts) whose life limitation is primarily the result of cyclic operation. This type of test may vary the time at various thrust or power settings and the sequence of thrust or power selections from that of the mission flight cycle. The applicant should select variations that produce maximum incremental damage per test cycle. Determining the relationship of the accelerated mission cycle test to the full mission flight cycle involves a complex analysis of stress, temperature, and resulting life for each affected part of the engine. The accelerated mission cycle test may run several major stress cycles during a given portion of overall engine test, resulting in a small number of engine hours in comparison to the number of major stress cycles demonstrated. The accelerated mission cycle test is generally not considered ideal for substantiating those engine parts whose lives are determined by hours of operation rather than by cycles. For those cases, other test or service experience data may be required to substantiate the IMI interval(s). The accelerated mission cycle test should include engine start and shutdown.

b. Test Engine Configuration. Section 33.90 specifies compliance by test demonstration using an engine that substantially conforms to its final type design.

(1) This includes items not normally considered part of the engine type design (for example, thrust reverser, air starter, engine build-up (EBU) hardware, etc.).

(2) The test should also be run with the engine in a typical installed configuration with representative airframe accessories and interfaces connected and operating. The typical accessory loads and bleed air extraction that would be experienced during the mission flight cycle should be scheduled throughout the demonstration test.

(3) For information on EBU hardware or installation configuration, the applicant should consult the installer or the aircraft certifying office.

(4) For turboprop applications, the test engine should have a representative propeller installed, and the applicant should incorporate applicable design features such as propeller braking and APU-mode operation into the test cycle.

(5) For turboshaft applications, the test engine output shaft should be loaded so as to simulate the appropriate characteristics of the main rotor of the intended installation. Potential main rotor characteristics include, but are not limited to, inertia and torsional vibration.

c. Test Parameters. The test may be conducted at sea level conditions if the test run effectively reproduces critical conditions of power/thrust, stress, component temperature, EGT, and unbalance vibration that would be experienced during a mission cycle.

d. Test Duration. The total number of test cycles will be a function of anticipated on-wing life and desired IMI intervals. Ideally, test duration should be equivalent to the anticipated initial on-wing life for the new engine model in a typical installation. The IMI intervals would support this target. As a minimum, the applicant will need to run a suitable number of cycles to establish a realistic set of IMI intervals and to show that a type design engine remains in a serviceable condition between required maintenance inspections.

e. Pass/Fail Criteria. The engine type design will be considered to have met the requirements of §33.90 when it has been shown to meet the following criteria:

(1) Over the test duration, the engine can deliver rated takeoff thrust or power for a sea-level hot day corner point operating condition without exceeding any operating limitations and is free of surge or stall or other significant anomaly when operated in accordance with the operating instructions provided in support of §33.5.

(2) The teardown inspection should show that each engine part conforms to the type design and is eligible for continued operation in service in accordance with the information submitted for compliance with §33.4. Hardware found to be unserviceable may be accepted on a case-by-case basis if appropriate inspections or limitations are established to remove the parts from service before failure or malfunction is likely to occur. Also, an applicant's formal plan for product improvement may be considered when dispositioning hardware.

(3) The §33.90 certification documentation should identify those parts of the engine that will have specific IMI requirements or recommendations. A formal plan should exist to include this information, including life limits, inspections, intervals, and serviceability criteria, in the ICA in accordance with §33.4.

f. Determination of Time/Cycle Intervals for Initial Maintenance Inspection(s).

(1) For a full mission cycle test successfully completed, the applicant may receive credit for the full number of cycles and full number of hours demonstrated during the test as the IMI interval.

(2) For an accelerated mission cycle test successfully completed, the applicant may receive credit for the full number of cycles for those engine parts for which the test cycle was demonstrated to be equal to or more severe than the design flight cycle.

(3) The applicant would not normally receive credit for hours in excess of those actually demonstrated. However, it may be acceptable, if the cycle used involved operation at high thrust settings for durations well in excess of those of the mission flight cycle, to consider credit for additional hours on a case-by-case basis. This approach requires caution; some parts of the engine will wear as a function of time at load, rather than from low cycle fatigue, and life extrapolation based on material property data alone is imprecise at best. Under these circumstances, it may be necessary to draw from other engine, component, or subassembly tests for supporting evidence.

7. FIXED ENGINE OVERHAUL PERIOD. If the engine is not intended to be covered by a structured maintenance program, the TC holder may recommend a fixed period overhaul as the IMI. Under this circumstance, the applicant should conduct the §33.90 engine test in a similar manner to that described in paragraph 6 of this AC, and the test should support the desired fixed overhaul period.